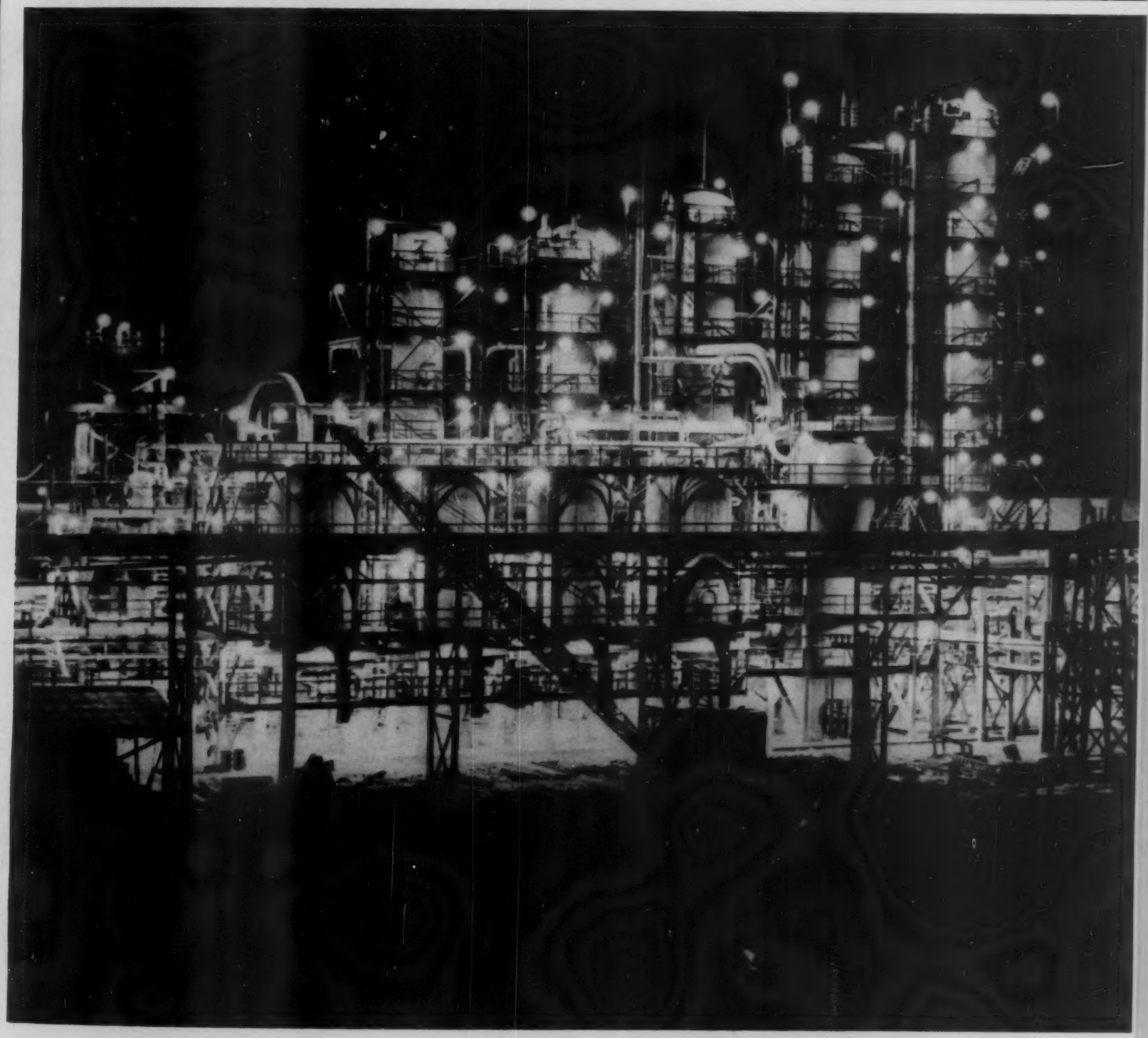
TECH ENGINEERING NEWS



OCTOBER · 1939

Familiar as your own face

. . . but do you know what's back of them?

Here's the set-up back of the familiar blue Bell emblem—

1. American Telephone and Telegraph Company, which coordinates system activities—advises on telephone operation — searches for improved methods.
2. 24 associated operating companies, which provide telephone service in their respective territories.
3. Long Lines Department of A. T. & T., which interconnects the operating companies and handles Long Distance and overseas telephone service.
4. Bell Telephone Laboratories, which carries on scientific research and development for the system.
5. Western Electric, which is the manufacturing and distributing unit of the Bell System.

With common policies and ideals, these Bell System companies all work as one to give you the finest and friendliest telephone service — at lowest cost.

C O N T E N T S

Vol. XX No. 5

OUR COVER THIS MONTH

Night View of a Combination Crude and Cracking Unit

OCTOBER 1939

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AND NEXT MONTH

The issue will be devoted entirely to the 1940 automobile

THE TECH ENGINEERING NEWS

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MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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WHAT PRICE TECHNOLOGY?

What am I being prepared for, is the question foremost in the student's mind today. The Institute replies for each of its courses.

This message to the Freshman Class from Dr. Compton is for the new men an appropriate introduction for the articles which follow. Nor would its merit be lost on the upperclassmen of the Institute.

Greetings to the Class of 1943
From President Karl T. Compton

TO most of us, and I am no exception, the number ten has a special significance in our counting of the years. This is one reason why I derive more than ordinary pleasure in greeting this year's incoming class, the tenth which I have welcomed to the Institute. Something of the spirit of an anniversary, recalling the stimulating years that have passed and holding the promise of rewarding years to come, is inescapable as I contemplate at this point of reference the coming and going of Technology students.

I find other and more important reasons, too, to celebrate your arrival. Through the efforts of its Corporation, Staff, Students, and Alumni, the Institute now places at your disposal recreational and educational opportunities and facilities superior to any available in the past.

You will be the first freshman class, for example, to use the new Briggs Field House and the superb athletic field finished this summer. You will find, rising upon the old athletic field, a splendidly appointed indoor swimming pool which should be ready for use next spring. I should say pools, for there will be two of them, one for racing and experienced swimmers, and one for practice. These new and attractive recreational facilities have been made possible by the generosity of Technology Alumni and will stand as enduring symbols of the active interest of Alumni in aiding you and your successors in living a well-rounded life at the Institute.

In addition to these new athletic units, you will have available many other facilities that the freshman class of a decade ago did not have. There is the Sailing Pavilion and our fleet of thirty-six dinghies for sailing on the Charles River Basin. For those who wish to exercise and develop their abilities as craftsmen, there is the Hobby Shop. The Technology Museum, with its many corridor exhibits and such special collections as the Dard Hunter Paper Museum which opened last June, is rapidly taking shape and is playing an increasingly important part in our educational activities.

Bearing more directly upon your central objective at the Institute and indicating a vigorous development of our educational program are the recent important additions to our educational plant. The Wright Brothers Memorial Wind Tunnel was dedicated last autumn, the William Barton Rogers Building with its imposing entrance on the west side of the main group of buildings was occupied a year ago, the Cyclotron Building, with its central feature, the cyclotron, is rapidly nearing completion, and plans for two other special research structures, one for a multi-million-volt X-ray generator and the other for studying Solar Energy, are now being completed.

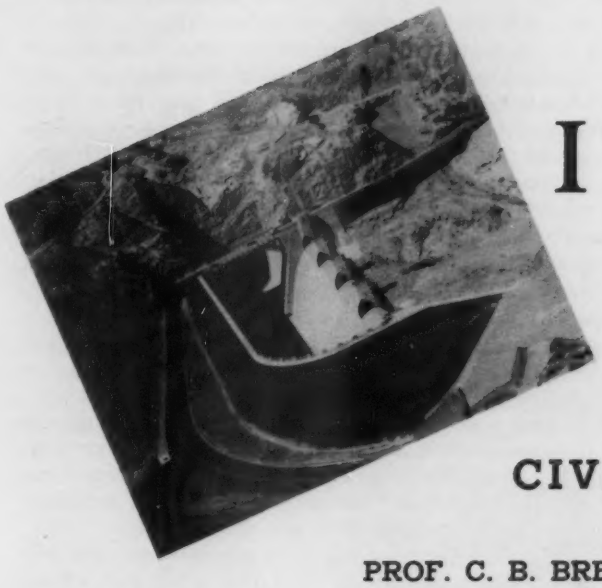
More important than buildings and equipment, however, are the men, the students and staff with whom you will come in contact at the Institute, and here again you are a favored class. You are favored because your class is a select group, perhaps the most carefully selected group which has thus far been admitted to the Institute. Out of those who applied for admission along with you only one out of three could be admitted. The other classes with which you will be associated were similarly selected. This means that you will live and study with an extraordinarily fine group of men and that they will contribute to your advancement through those subtle and friendly ways by which association with active minds and differing personalities always contributes to our growth. This process of selection means, too, that much is expected of you, and that having qualified as a member of this group, you have an obligation, along with the opportunity, to share to the utmost in the life and work of Technology. There is a challenge in this obligation and opportunity that cannot fail to appeal to you.

The most important feature of an educational institution is its staff, since in the last analysis it is the staff and not the laboratories or the curricula which determines the quality of its education. The staff of the Institute is the asset of Technology in which, in my judgment, we can take the greatest pride. It is characterized not only by professional ability and eminence, but by a loyalty and a spirit which I have not seen equalled in any other institution. Particularly do I wish to emphasize to you that it is a friendly group of men, ready at all times to take a keen interest in your personal welfare. I hope that you will make a point to find out for yourself that this is true, that each member of the staff will welcome the opportunity to know and help you.

And finally, I find another reason for gratification in the fact that you have chosen engineering, science or architecture as your field of concentration, because I am convinced that they provide a sound foundation for life regardless of the type of work in which you will ultimately be engaged. A distinguished authority on education, Dr. W. S. Learned, has said: "I know nothing more hopeful for society than to combine a good engineering education with a sound philosophy." If you participate fully in the life and work of Technology you will obtain a good engineering, scientific, or architectural education combined with a sound philosophy and will be prepared to become a well-rounded, well-

adjusted, productive citizen. In the face of this prospect and this opportunity I can indeed greet and welcome you with enthusiasm.

KARL T. COMPTON,
President, M. I. T.



I

CIVIL

PROF. C. B. BREED

In the broadest sense the civil engineer builds and operates cities and towns and the transportation systems which link them to less developed portions of the country. He designs and constructs buildings for housing, manufacturing and commerce; provides for a proper supply of water for consumption, industry, and fire protection; and removes wastes safely. He harnesses the rivers to provide power and light and to safeguard against floods, and makes rivers navigable and harbors safe. He builds highways, railways and airports, and is concerned with the structural aspect of transportation vehicles. He bridges rivers and valleys, and tunnels through mountains to facilitate transportation. The "art of using the varied materials of nature and of directing the great sources of power in nature for the use and convenience of man" finds the civil engineer active in basic construction projects covering a wide range.

Although most civil engineers specialize in one of the broad subdivisions of the profession, all these branches rest upon a relatively compact body of principles. Thus while civil engineering is the broadest in scope of the engineering professions, fundamental knowledge of materials, mechanics, mensuration and economics forms the basis for a large part of his technical development.

But of perhaps greater importance is the development of the character and mental habits of those entrusted with the grave responsibilities which are intrinsic to the profession. The civil engineer deals in realities. The ability to think clearly, plan carefully, and make decisions promptly are among his necessary attributes.

The magnitude of the undertakings of the civil engineer calls for the coördination of the efforts of many individuals. Consequently leaders in this profession must direct men as well as adapt materials.

II

MECHANICAL

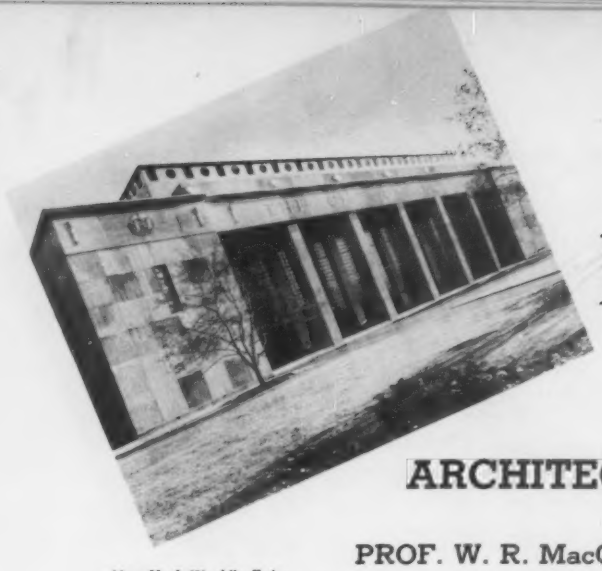
C. RICHARD SODERBERG

J & L Steel Corporation

The industrial developments of recent years have accentuated the importance of the mechanical engineer in many industries not directly concerned with products in the field of mechanical engineering. The electrical and chemical industries, for example, have gradually come to appreciate that their operation requires expert knowledge not only in their special fields but in a variety of subjects related to mechanical engineering as well. As a consequence of this tendency, the mechanical engineer can look for employment in practically all branches of industrial activity. Moreover, it is only in very rare instances that the graduate knows with certainty the special field in which he will operate. This widening of the field of activity requires a program of education in which special emphasis is given to broad scientific training on fundamental subjects, while specialized knowledge of the product of any one industry is reduced to a minimum. The practical experience must be obtained by service in the industry.

The course in Mechanical Engineering at the Massachusetts Institute of Technology has been planned with this development in mind. It is intended to prepare the graduate to enter any industry dealing with heat, power, materials, and machinery, with emphasis on the fundamental subjects such as mathematics, physics, applied mechanics, and chemistry, in which a thorough knowledge is essential to all branches of mechanical engineering. The study of materials, particularly the metals, is given special attention. Throughout the course the instruction by lectures and recitations is paralleled by laboratory work and drawing-room activity. In the fourth year, the student may concentrate on a specialized field by selecting one of four options, dealing with general mechanical engineering, automotive engineering, refrigeration, and air conditioning and materials, respectively. The principal purpose of these options is to give direction to the student's energy and initiative.

The program of the Graduate School is based on the same premise. While the possibilities for specialization are greater, the principal aim is to develop the scientific approach to the problem of mechanical engineering. A coöperative course, covering five years and leading to the degree of M.S., has been arranged with the General Electric Company. This enables the students to spend the summers and part of the last three years studying the technical and executive problems of a large industry. Beginning with the present academic year, an opportunity will be given to a limited number of students of superior ability to join an Honors Course in Mechanical Engineering. This course will enable the students selected to pursue a coördinated schedule of studies through the Senior and Graduate years.



IV

ARCHITECTURE

PROF. W. R. MacCORNACK

New York World's Fair

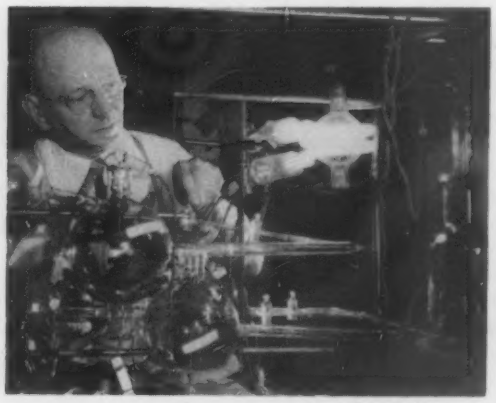
The School of Architecture trains its students in the art of building useful structures of beautiful design and fine craftsmanship in relation to the outward forces of our day. The students learn that the development of this art is not the expression of an abstract idea on paper, but that the ideas finally expressed are the result of social and economic forces which exist in every age and which influence the thinking of mankind.

It is not the function of the School to impose upon its students any particular style — past or present — but to trace the development of the art from the earliest time to show the reasons why various styles have come into being and their relation to the forces which exist during their development.

In our close attention to the problem of the individual structure in the past, the broader problems of planning and the effect of the economic and social forces on architectural developments have been overlooked. This failure has brought near bankruptcy to our cities and aesthetic bankruptcy to a great art. It is evident then that important work lies ahead in equipping our students to cope with these problems.

The architectural style of a building is relatively unimportant, provided it is beautiful, but the architectural pattern of our cities, towns and villages is of great importance to the nation. With the growing idea of large scale and mass production in building, and the opportunities for planning the architectural pattern of our cities, the architect of the future will occupy an increasingly important place in every community.

It is therefore the duty of the School of Architecture to educate men of imagination, character and courage, not only to be builders of structures, but leaders in the broader phases of the profession of Architecture.



V

General Electric Co.

CHEMISTRY

PROF. AVERY A. ASHDOWN

In pursuing its main objective of providing a good general education based on chemical science as the major field of study, the Department of Chemistry looks beyond the four years of undergraduate student life at the Institute, to jobs which may be available after graduation. The course aims to stimulate the research attitude and, in general, its graduates have developed the frame of mind which looks for improvement in old processes and for discoveries of new things. By a suitable selection of electives, a student may gain a knowledge of some allied field in which he may expect a career where a fundamental knowledge of chemistry is important. Thus there are well-planned series of electives in biology, ceramics, economics, metallurgy, mineralogy, textiles, and so on.

In addition to these studies in science, the course is supplemented by instruction in mathematics, physics, English, history, and the very useful foreign languages, French and German. Such non-professional subjects give the student not only useful tools for his immediate career but, as well, give him a better background for meeting the important problems of human relations which are bound to arise in every stage of life.

Students who are headed for a professional career in chemistry will wish to go into the graduate school. Their preparation enables them to attain that broader education in the fundamental branches of chemistry necessary for meeting the requirements of the doctorate and to specialize at once in some particular field such as inorganic, physical, or organic chemistry. Furthermore, experience has shown, abundantly, that graduate study will be successful in such different fields as geology, textiles, medicine, and the law, with the course in chemistry at M. I. T. as the background.

VI

General Electric Co.

ELECTRICAL

PROF. H. L. HAZEN

The term "Electrical Engineering" carries two implications. "Engineering" implies the application of science to achieve a result useful to man in the least costly way. "Electrical" implies the use of electricity in this process. The electrical engineer is one professionally qualified to work in this broadly defined field.

As we all know, electricity is used practically in a

wide variety of ways. For the transmission of power and intelligence over long distances it is the fastest medium known and under many conditions the most economical. These are the major applications of electricity. At the same time electricity is so adaptable and readily controlled that it is often used where distance is not a factor, as in an inter-office telephone system, or a ship's main drive; or for conveying information concerning the instantaneous pressure inside an airplane engine cylinder.

Technically, work on electrical applications may often be difficult and exacting, requiring hard scientific thinking in mathematics and applied physics coupled with a generous portion of sound common sense, Yankee ingenuity, and co-operativeness with others; yet those in such work usually find its fascination proportional to its difficulty. The young well-trained electrical engineer is likely to be thrown very early into the midst of new and significant developments where his contributions are limited only by his ability to analyze problems and to devise sound and economical solutions. As he matures and acquires experience his work usually shifts from the technical toward the administrative, laying more stress on his sound judgment, his ability in balance-of-evidence thinking, and his ability to understand and work with others.

VII

VII-A

Frederick J. Weber

BIOLOGY and PUBLIC HEALTH

DEAN S. C. PRESCOTT

The biological sciences have in recent years assumed a very important place, not only in education and in the medical profession but also in industrial affairs. Bacteriology, including such other micro-organisms as yeasts and molds, underlies a great group of fermentation industries such as the alcohol, vinegar and acetic acid, citric acid, and butyl alcohol and acetone manufacture. Biochemistry is rapidly assuming new importance with the vast developments in the use and study of enzymes and the great strides which have been made in the synthesis of the vitamins. Industrial hygiene is more broadly recognized than ever before. Problems of food manufacture and preservation, as exemplified in such great industries as canning, dehydration, quick-freezing and general refrigeration, are commanding much attention. The study of nutrition has passed from an academic or theoretical stage to one of great importance. And with all these growing developments there has also continued a deep and increasing interest in public health and sanitation, water supply and waste disposal, disease control both by methods of treatment by vaccines, sera, etc., and by the control of the environment through public health engineering. The need for training in Health Education methods and principles is making new demands for specialists in this field, and for professional training in public health administration.

In all the above fields of biological application and in the still newer field of Biological Engineering and Biophysics, the Department of Biology and Public Health is deeply concerned and offers well organized programs leading to well rounded preparation for professional service in the fields which have been mentioned and others of related character. There is, in a sense, a new era in which the fundamental knowledge in some branches of biological science is assuming great and increasing practical importance.

Recognizing this, the Department has established the four definite programs which will be found in the Institute catalog as Option 1, Biology and Public Health, in which the emphasis is placed on breadth of training for the various aspects of public health administration. Option 2, Public Health Engineering, which combines solid training in bacteriological and other public health subjects with a strong fundamental course in engineering. Course VII-A, Biological Engineering, which is elsewhere described in greater detail. Course VII-B, Food Technology and Industrial Biology, which is designed to fit men for technical positions in the rapidly growing field of the food and fermentation industries. This is a branch in which the possibilities for interesting and useful employment are varied and fairly certain, for the food industries are essentially basic and are bound to be necessary for national development.

Graduate work in all these subdivisions is available. Special mention should be made, however, of the opportunities for training in Health Education for those who wish to look forward to responsible administrative positions in this important branch of educational work.

In addition to the S.B. and S.M. degrees the Department offers degrees of Ph.D. and Dr. P.H.

BIOLOGICAL ENGINEERING

PROF. JOHN W. BUNKER

Statistical evaluation of demand may be impossible for that which comprises novelty, and its potentiality then must be estimated by investigation, logic, and analogy. Just as the market for television sets may be estimated in light of the experience with radio broadcast receivers, in like manner the forecast of employment of biological engineers can be made with more sureness because of the success of chemical engineers. From a hundred letters of inquiry addressed to heads of business houses or research laboratories, fifty replies indicate a positive interest in securing the services of M. I. T. graduates of Course VII-A and three express the opinion that the firm addressed can see at this time no problems involving biology. Typical of the vision in successful industries are the following citations: from the manufacturer of a food product: "If we had received a similar letter four or five years ago, our answer would probably have been that . . . (our firm) . . . could not profitably employ a research man who had special training in the group of subjects you teach in your Biological Engineering course.

"Today, the answer must be different, for we have definite needs for men who have a fairly thorough grounding in theoretical and experimental physics, plus some training in bacteriology and physiology, for the

very good reason that we have found that progress in our general research constantly brings us to a need for studies in these fields . . . you can certainly consider that . . . (our firm) . . . will be able to make good use of men who have received a thorough training in the subjects you have outlined."

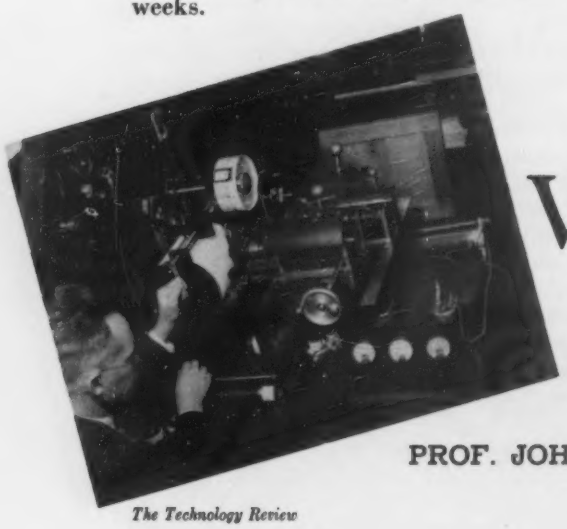
From a manufacturer of First Aid equipment: "May we say that it is our belief there is need for men trained along the lines suggested in various industries. I believe that we could use such a man to good advantage." Again, from a producer of serums and vaccines: "There seems no question but that some of the most fundamental discoveries have been made only because more efficient instruments of newly developed techniques have been applied to our problems. We are also interested in the possibility of being informed concerning any man you consider especially promising among those graduating. We have at times taken men into the organization even when at the time we had no definitely prescribed position."

From one of the largest manufacturers of chemicals: "There is no doubt in our mind that a curriculum in Biological Engineering such as you are inaugurating will turn out men excellently prepared for work in the development and use of new therapeutic agents and methods. Such men will be very much in demand in the manufacturing pharmaceutical industry."

From "Packing Town," Chicago: "I am sure students with this background of training will find very useful employment in such industries as our own . . . specifically, I would be most happy to see some of your better students trained according to the curriculum you have outlined . . . to consider them for such vacancies as we may have."

The above citations are not specially culled from the group of replies, they illustrate the attitude of receptivity toward and of active interest in the human product of Course VII-A.

Of the first two men to graduate from this course, one secured employment upon his first interview, previous to receiving his degree, and the other within two weeks.



The Technology Review

VIII

PHYSICS

PROF. JOHN C. SLATER

Physics and chemistry are the two fundamental sciences on which most of engineering is based. In particular, mechanical engineering, electrical engineering, aeronautical engineering, as well as large parts of chemical engineering, and many other branches, really are applications of physics. It is being recognized more and more that fundamental work of investigation in these fields is best done by research workers with a thorough training in physics, such as is obtained in Course VIII.

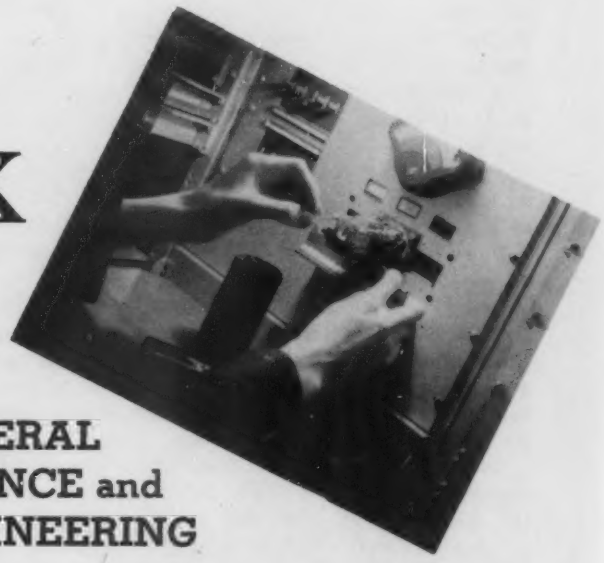
Physics consists of the familiar branches of mechanics, heat, light, sound, electricity. To these are added in these days atomic structure, and nuclear physics. Some of these subjects are of unusual interest in their own right. The study of optics, for instance, ties in with photography, and all its recent applications in the motion picture field. Sound and electricity combine in the field of communications, the radio, and the phonograph. Electricity and atomic structure, leading to electronics, find application in vacuum tubes and electric arcs, devices of the greatest importance in the electrical industry. Atomic structure as applied in spectroscopy leads to methods of chemical analysis of extraordinary delicacy. X-ray, a branch of atomic structure, yields detailed information about the positions of atoms in crystals, and other problems of great importance to metallurgists and geologists.

There are two options in Course VIII: General Physics and Applied Physics. Both of them include thorough training in physics, a good deal of mathematics and chemistry, and considerable elective time, in addition to the subjects common to all the courses of the Institute. The option in Applied Physics contains somewhat more chemistry and some metallurgy, and somewhat less mathematics, than that in General Physics, but the differences are not great. Included in the physics are subjects in both experimental physics and theoretical, or mathematical, physics, illustrating the fact that a physicist must be good in the laboratory and handy with experiments, and at the same time able to handle mathematics. It is a difficult combination, and many students are not cut out to be physicists, but for those who are it is a fascinating subject, and a very rapidly growing and developing one. The last thirty years have seen a development in our fundamental ideas of physics which is more striking than almost any other similar period, and certainly as striking as the progress of any other science. The Institute and the Department of Physics, with their emphasis both on teaching and research, are set up to contribute to this progress, and at the same time to bring students up to date and to send them out in a position to be leaders in future progress of the science.

IX

GENERAL SCIENCE and ENGINEERING

PROF. R. G. HUDSON



Bell Telephone Laboratories

The Institute has always considered it wise to serve both table d'hôte and à la carte courses. The original purpose of Course IX was to provide a well-rounded education in either science or engineering with sufficient optional opportunity to look up some of the side streets.

It is not in the general scope, however, that Course IX has proved most attractive. Most students at the beginning of the third year, or even at the beginning of the fourth year, have become seriously interested in some branch of science so that most of its upperclassmen are working on a special objective with a relevant thesis.

The choice of electives in Course IX depends upon the purpose for which the course is selected. At present the registrants are divided into two distinct classes.

In the first class are those students who wish to complete a course agreeing literally with the title. In this class electives are chosen which extend the understanding and application of all the engineering sciences including economics, social science, and business. The schedule of electives is approved only when it exhibits a proper sense of balance.

The second class contains those students who wish to complete a course with an unusual purpose. The schedule often represents a pioneer curriculum which may develop into a standard course. The choice of electives is governed completely by a definite adherence to the particular objective.

The following list of objectives will give a comprehensive idea of the nature of some of the recent schedules: Actuarial Mathematics, Advertising, Biochemistry, Business, Ceramics, Economics, Engineering Finance, Food Technology, General Contracting, High Speed Printing, Industrial Construction, Industrial Marketing, Insurance Engineering, Laundry and Business Engineering, Law School Preparation, Machine Design, Manufacturing Engineering, Mechanical Engineering and Business, Meteorology, Optics, Packaging Engineering, Patent Law Preparation, Photochemistry Photography, Power Plant Engineering, Premedical, Road Building, Safety Engineering, Sales and Production Engineering, Sound Engineering, Teaching, Technical Journalism, Testing Materials, Textile Engineering, Transportation Engineering, and Water Supply Engineering.

General Electric Co.

X

CHEMICAL

PROF. W. G. WHITMAN

The chemical engineering graduate will probably enter some industry in which chemical operations play a significant role. Formerly this implied the rather narrow group of industries described as "Chemical," but today the surge of chemical developments and technology has invaded most fields of modern manufacturing. Petroleum, rubber, synthetic ammonia and alcohols, artificial fibres and plastics are examples of enterprises based upon chemical reaction which offer real opportunity to the young graduate.

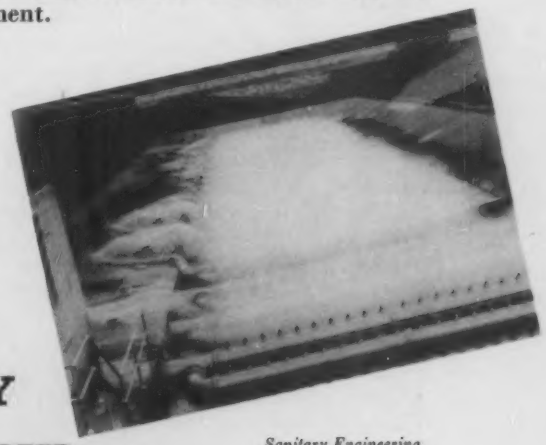
As industry has become more technical its need for well-trained men has increased, men who can develop, design and operate new processes and improve existing ones. Such men must be broadly prepared in chemistry and in the fundamentals of science and engineering. Their activity as young engineers will be technical in nature, comprising such work as plant operation, technical service to the manufacturing or sales organization, development of new processes from the laboratory to the plant scale, process design, and the economic appraisal of projected technical developments. Promotion often leads them to positions of executive responsibility, where a sound engineering background and experience can be applied to the problems of plant managers, development directors, and senior executives.

The course in Chemical Engineering, recognizing the diversity in the probable activities of its graduates, offers a broad preparation in the fundamentals of the profession and attempts to develop the student's capacity for intelligent analysis, clear reasoning and constructive action. The curriculum may be briefly characterized as including a major requirement in chemistry (analytical, physical, and organic), work in mechanical and in electrical engineering which is adapted to the needs of the chemical engineer, third- and fourth-year chemical engineering subjects, and a fair proportion of time for cultural studies. In a program of such scope the more advanced professional subjects must be deferred for graduate work, and a fifth year, leading to the Master's degree, is recommended for men who show marked promise for professional accomplishment.

The Department's School of Chemical Engineering Practice, available to seniors and to graduate students, offers a unique opportunity for the student to develop the power to apply his training to the solution of typical problems in industrial plants. Qualities of initiative, responsibility, resourcefulness, and the importance of constructive personal relations with his associates and with plant personnel are stressed as factors vital to practical achievement.

XI

SANITARY



Sanitary Engineering Department, M. I. T.

PROF. C. B. BREED

The field of sanitary engineering deals principally with water works and works for the treatment and disposal of sewage and other wastes. The field includes the preliminary investigations for, and the design, super-

vision of construction and operation of works for both public and industrial water supplies; and similar complete service in connection with municipal and industrial wastes. The sanitary engineer must be competent not only to design and construct such works, but he must also be a competent authority on water quality and the treatment processes. The public looks to the sanitary engineer to solve the many problems arising out of the growing pollution of our rivers and harbors by wastes of all kinds. Such expert service requires adequate training in chemistry and biology in addition to the civil engineering training required for design and construction.

The Sanitary Engineering Course at M. I. T. (Course XI) is one of the four undergraduate curricula in the United States which has been approved by the Engineers Council for Professional Development as offering adequate preparation for the field of sanitary engineering.

The demand for properly trained sanitary engineers is such that it will warrant investigation by those interested in entering the profession. Due to the more exacting demands of the public for good water, the growing interest of government in the regulation of the pollution of our water courses, and recent highly technical developments in processes of water and waste treatments, the need for sanitary engineers who have thorough basic training in chemistry and bacteriology will doubtless be on the increase for many years.

Bethlehem Steel Co.

XII GEOLOGY

PROF. HERVEY W. SHIMER

The majority of our graduates go either into the geology of mining or of petroleum.

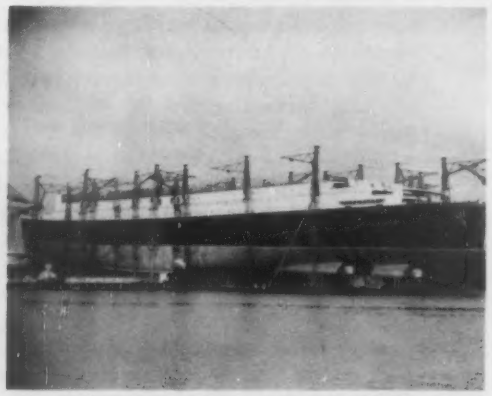
Some engage in the exploitation of other nonmetallic minerals, such as coal, sulphur, nitrates, potash, etc. Besides the necessary field work, many of these deposits require laboratory work along petrographic, x-ray, spectroscopic, and micro-chemical lines.

Other graduates go into engineering geology where the geological positions include field geologists and consulting geologists. These must have a thorough working knowledge of structural geology, petrography, hydrography, glaciology, geomorphology, and sedimentation. The work includes the examination of foundations for buildings, bridges, dams and roads, the finding of water supplies for homes and industries, advice on the many geological problems arising in the making of tunnels, pipe lines, aqueducts, sewers and subways, in the location of suitable sources of building materials of various sorts, and in shore-line protection.

Other men join geological surveys, national, state, or provincial. Some become teachers in colleges or high schools or enter museums or become connected with the publishing of various geological magazines.

In mining geology the positions include the consulting geologist and the resident mine geologist and his assistants. The work may be prospecting for new ore deposits or the field and laboratory examination of known ore deposits with the aim of directing mine operations in the location of new extensions of the deposit. The work includes the sampling of ores for assay, a study of the structural relations of ores to country rock, petrographical, micro-chemical, and spectroscopic studies of ores and enclosing rock.

In petroleum geology the positions include field geologists, geological scouts (who obtain information on drilling and leasing), micro-paleontologists, geophysicists, and geological draftsmen. The work may be prospecting for new oil fields in which usually both the field geologists and the geophysicists take part, or the locating of wells in known oil fields. Other work includes the interpretation of drill specimens by petrographic, paleontologic, stratigraphic, and sedimentational studies. These are especially valuable in the extension of existing oil pools.



The Times

XIII NAVAL ARCHITECTURE

PROF. G. F. OWEN

Imagine the world without ships! Every continent and every island would be a world alone. Ships have made the modern world and the accomplishments of peoples on land, and their degrees of culture have always gone hand in hand with sea power. The building of a modern ocean-going ship demands the most accurate and varied artistic and engineering knowledge available. Practically every known art and trade enter into the modern ocean-going merchant ship.

The course in Naval Architecture and Marine Engineering (XIII) at the Massachusetts Institute of Technology deals intimately with the story of ships. It provides instruction in the theoretical and practical methods for the design and construction of modern merchant ships and their equipment.

As a part of his work in this course, each student draws out the design of a merchant ship and its machinery for a given service in accord with the best and most modern practice, bearing in mind not only the logical development of the design, but also the requirements of the classification societies, insurance, and governmental inspection. On the subject of powering, careful study is made of steam reciprocating and turbine machinery, also internal combustion engines.

Although the number of students taking this course is relatively small — averaging about fifteen per class

— yet it is believed that this small number possesses advantages, such as close individual attention during undergraduate work and more careful placement after graduation. Inspection of our Register of Former Students will indicate that Course XIII graduates are living up to the best traditions of M. I. T.

XV

BUSINESS ADMINISTRATION

PROF. E. H. SCHELL

What kind of work does Course XV prepare for?

For managerial work in manufacturing. The ultimate position prepared for is that of major executive. This requires a number of years of interneship in industry.

The chart shows the rate at which graduates of fourteen classes attained major executive positions in the years following graduation.

What do XV men do immediately upon graduation?

Earn a living while they are gaining necessary experience and maturity for executive work. The choices of graduates may be divided approximately as follows:

%	*Choice of Job*
30	Engineering (technical)
20	Production (including training courses)
15	Financial, accounting or control
12	Executive (of an initial nature)
10	Sales engineering
6	Personnel and the like (non-technical)
7	Miscellaneous

Are such opportunities offered XV men by large, medium or small companies?

All are represented. In general, XV men tend to seek opportunities in the medium sized organizations where all aspects of management may be conveniently open to study. Again, major executive jobs are held more likely of attainment in the medium and smaller sized enterprises.

What follows after these initial jobs?

The men preferably increase their experience by moving about from one division of the business to another. Beginning as trainees, operators, laboratory men, salesmen, or clerks, they normally proceed to staff positions (assistantships) or to preliminary executive posts. Increasing age and experience bring ultimate promotion for the majority to major executive positions. A small number go into business for themselves.

Do Course XV men change companies frequently?

There is a moderate amount of change. Records show that men progress fastest who remain for longer periods with a single company.

Just what kinds of work were undertaken by last year's seniors?

The largest number of seniors undertook to learn the business of companies manufacturing aluminum products, ammunition, airplanes, automobile accessories, brass products, business machines, chemical products, electrical equipment, leather, metal specialties, paper, radios, shoe machinery, soap, steel products, and textiles.

The next largest group chose sales training in companies manufacturing petroleum products, steam turbines, water system equipment, and miscellaneous machinery.

A smaller number undertook technical activities in concerns producing electrical and fire protection equipment. Building construction, book publishing, fire insurance, and banking were also chosen as initial opportunities.

XVI

American Air Lines

AERONAUTICAL

PROF. R. H. SMITH

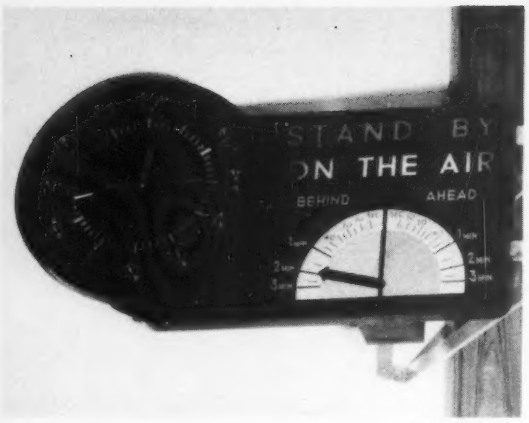
Perhaps the most helpful way to describe aeronautical engineering as a career, within the short space of this article, would be first to outline the rather unique characteristics which distinguish it from other engineering fields, then to discuss briefly the typical jobs which the beginning engineers get after graduation, and finally to describe typical top-bracket positions toward which they may later aspire and the rates of progress which are commonly made toward them.

Aside from its romantic lure and its attractiveness because it is still relatively new and undeveloped, aeronautical engineering is one of the most precise and rigidly censored of all the engineering fields. At the same time it is probably the most difficult of all branches of engineering that depend upon mechanics as a principal part of their foundation.

The airplane requires the cleverest kind of precision engineering in structures and aerodynamics; it must be powered by incredibly light, powerful and reliable motors; it must be equipped with many instruments of special design and precision; it must be designed to resist high motor vibration and noise, and to carry its passengers with a maximum of comfort. Rigid mechanics, involving six degrees of freedom, advanced gyroscopic theory and fluid mechanics of advanced grade, are representative of the common engineering aids required in design.

Typical starting positions obtained after graduation are: revising drawings to carry through an alteration of some part of an airplane under production, stress analyzing some proposed alteration, checking comprehen-

(*Continued on page 105*)



Frank Rondt

Modern Broadcasting Studios

THE APPLICATIONS OF ACOUSTICAL SCIENCE HAVE RESULTED IN A MORE SENSIBLE APPROACH TO STUDIO DESIGN

A. CARLETON JEALOUS '42

THE big broadcasting companies of this country represent one of the most modern, fastest moving businesses today. Glance at the NBC Master Control Desk pictured on this page, note the extravagance of switches, buttons, signal lights; think of the maze of intricate circuits that must be changed and rearranged every time a program ends and a new one goes on the air — this symbolizes the quick action which is necessary at all times to keep a broadcasting network running smoothly. Observe how the ultra-modern design of both the inside and outside of the studios pictured illustrates the manner in which large radio systems keep themselves up-to-date. Though symbolic, the ultra-modern design is mostly functional.

In the not very distant past, big studios were not much more than business offices with drapes on the walls to prevent echoes from reaching the crude microphones. The National Broadcasting Company was the first to build studios of the "floating" type, suspended from the main building structure on steel clips. These, located at 711 Fifth Avenue, New York, furnished the experience needed for the construction of the more nearly perfect Radio City studios. More recent studios of the NBC network have been developed from those of Radio City. NBC's Hollywood plant represents its greatest achievement in broadcasting facilities as likewise does the Columbia Broadcasting System's new Hollywood center of operations.

The modern broadcasting studio is the latest in acoustical perfection. The new studio theater is a model from which many movie houses might well take cues. These new show places, the last word in comfort and convenience, have well-managed air conditioning systems and large comfortable opera seats.

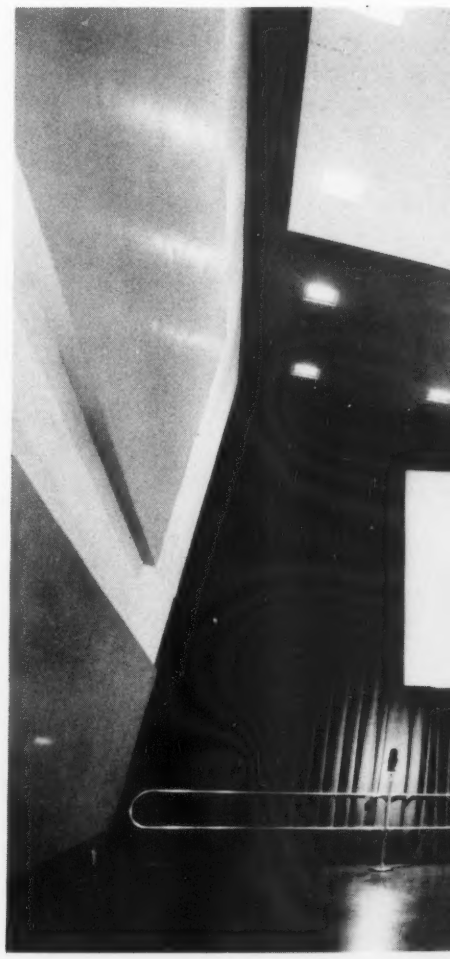
According to Norman Bel Geddes & Co. there are at present two fundamental factors to be considered in the construction of studios. The first one is that most stage-trained radio performers need visible audience reactions to induce good performances. The second factor has to do with the opposite viewpoint taken by radio-trained performers as well as by acoustical engineers and radio technicians. This group prefer studios with audience capacities limited to observation booths.

There are many points in favor of the second factor. Most important is the fact that more perfect acoustical and electrical control of reproduction of sound is possible in this type of studio. Also, voices not suited to long-range auditory perception can be modulated with other parts of the presentation to produce excellent results. These facts alone may make the second fundamental factor the final determinant of future basic studio design. Recent developments in research work point to the studio shut off from direct auditory contact with the audience.

By developing means of complete control of all sound from its incipient stages to its actual output into the ether, broadcasting companies will be able to provide concerts, operas, and theatricals in comparatively small space but with the desirable acoustical characteristics of a regular concert hall or theater. Such feats can be accomplished by the addition of the necessary sound factors providing space effects and auditory perspective to simulate large auditoriums and audiences.

Before proceeding further let us see what happens to sound imprisoned by the walls of a room. If the walls are hard and dense the sound will be reflected readily for a period of a few seconds. While if the walls are of microscopically porous materials the sound will be absorbed, making the period of what little echo there is very short compared to that of the hard-walled room. Different materials absorb varying amounts of sound at different frequencies. The more totally absorptive a room is the sooner will the sound become inaudible. The reader may have noticed that in a hard-walled room speech is practically unintelligible; this being due to the jumbling of the many echoes which have not had the opportunity to die out before the creation of new sounds. In other words, an overlapping of reverberating sounds took place.

Now, microphones are much more sensitive than the human ear and they "hear" the faintest echoes. That is why reverberations must be minimized in the studio. Old methods of control consisted of varying the amount of draperies hanging on the walls, the carpeting on the floor, and



limiting the audiences to certain sizes depending upon the desired effect. A new method used in Radio City by NBC relies mainly on remotely controlled panels which slide in and out of wall pockets. Program technique is another means of control: by proper arrangement of all artists and other sound-producing media in the studio, a uniform blend of sound is picked up by the microphone with all the component parts in the desired relative proportions.

A reverberation, to redefine the word, is a reflection of sound back and forth between parallel surfaces lasting a certain length of time, depending upon the constitution of the reflecting surfaces. It is measured as "reverberation time," which is defined as the number of seconds for the intensity of reverberating sound to die away to a millionth of its initial value, representing a decrease of sixty decibels.

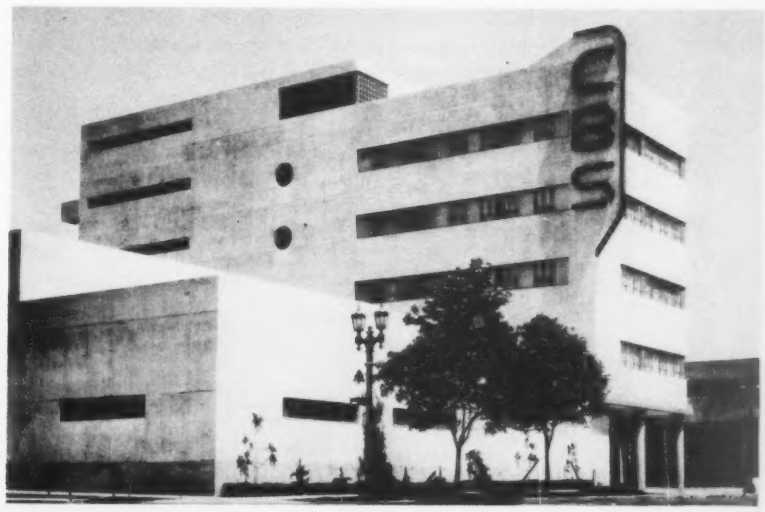
Small rooms well deadened may have reverberating times of three-tenths or four-tenths of a second. Large rooms with hard, dense walls may have reverberating times of six to eight seconds. The ideal period is neither too long nor too short. Thus new CBS studios are designed with reverberation times from four-tenths of a second to one second, depending on the size, shape, and volumetric space of the studio. Variable factors in these time values arise from variable size audiences and performing casts. These factors have been reduced considerably in the new CBS studios in Hollywood where the chairs are heavily upholstered, thus absorbing nearly as much sound as if the studio were filled.

Two developments in the modern science of sound in the last few years form the focal point of the design of many of Columbia's new plants. First is the use of a definite room echo to increase brilliance of music and speech, and second is the use of carefully designed wooden wall panels to act as sounding boards for improving the richness of sounds.

The reader may note in the pictures of some of the CBS studios the words "Live End" and "Dead End" printed on the floor. "Live End" denotes that end of the studio which is finished in sound-reflecting surfaces, while "Dead End" is the opposite end of the room finished in sound-absorbing materials. The objective in having two opposite walls finished in such a manner is to obtain for each sound produced one strong echo, lending a pleasing effect of liveness to the studio without the undesirable flutter caused by continued reverberation of the sound. This procedure is not applicable to studios greater in length than seventy feet, since the echo can not cover the distance quickly enough to fuse with the initial sound. In the large room the echo would be heard separately, producing what is called a "back-slap."

A direct echo between two parallel, sound-reflecting walls produces an undesirable flutter by several periodic reflections of the same sound. Thus in new studios all reflecting surfaces of side walls are built V-shape or in some other manner to prevent direct reverberation.

Photographs courtesy of Columbia Broadcasting System



Most novel method employed is in the Columbia studios in Hollywood. The smaller studios were built with inclined walls and ceilings, the inclination being one foot in every ten.

To obtain good quality in speech and music for pick-up by the microphone, it is necessary to preserve or reproduce all of the frequencies of the initiated sounds. Since the various sound-absorbing materials take in differing amounts of sound at different frequencies, specific sound-absorbing media must be chosen for all surfaces to produce as nearly as possible uniform reverberation at all frequencies. CBS specifications include, as the standard wall and ceiling sound absorber, a four-inch thickness of rock wool, covered with perforated metal accurately gauged to provide uniform absorption of the whole range of sounds.

Brilliance is added to music by thus controlling the frequency characteristic of the studio because it makes possible adequate audibility of the higher frequency tones and over-tones which are variations of the main pressure wave. In a studio that is dead or has unbalanced reverberatory qualities, the high frequency tones are lost or obscured.

Wooden panels on parts of the wall areas in many

new studios are the result of the experience of musicians in concert halls finished in wood. They believe that wood induces richer, more sonorous tones. The panels, fastened only at the edges, are free to vibrate as sounding boards. This is a good illustration of the fact that modern studio design is functional. The wood was not used because of attractiveness alone, but because of very desirable acoustical properties.

To soundproof studios from external noises a completely new structural method had to be developed. The "floating" method consists of hanging the studio from the main walls of the building on steel clips insulated from the main structure by felt pads. The four large studios in NBC's Merchandise Mart quarters in Chicago rest on springs instead of being hung.

Wire lath and plaster are applied to the studio framework and are separated from the final fabric cover by a two-inch rock wool blanket and perforated asbestos-cement board. Aerated concrete blocks are used in the main walls. All floors have an additional outside layer of concrete concealed by linoleum or carpeting.

In the new Hollywood Radio City of NBC, though the plant appears to be built all on one foundation, actually each of the four auditorium studios rest on separate bases. The sound problem in constructing this plant was greatly simplified because of ample space and absence of many extraneous noises. Only one of the large auditoriums has the standard sound insulation since it contains an organ and is situated over the air-conditioning unit.

All modern studios have "sound locks" for entrances. These are vestibules with double soundproof doors lined with lead.

Studio theater specifications require larger, more comfortable seats than standard theaters to induce less noise and to allow rapid filling and emptying of the auditorium.

All modern network studios and many independent stations are air-conditioned. Since specifications allow no windows, air-conditioning is absolutely necessary. Lighting is taken care of by the general, indirect illumination method which provides uniform light throughout the whole room. In some cases, such as General Electric's new quarters for NBC-operated WGY, glass block walls allow the passage of daylight into the studio.

Perhaps the reader is wondering about the windows that face the stage in the studios. These are separate booths for general observation by sightseers, for clients, and for the technicians who control the programs. Since all presentations must go on the air without the slightest delay, stage layouts must be planned not only for desirable sound effects but also so that the program director will always be in direct visual contact with the technician's booth. Note the prominence of clocks to insure the exact timing of all programs.

The future of radio broadcasting stations is open to several possibilities well worth consideration here. The Norman Bel Geddes & Co. research department is working on electrical and mechanical methods of controlling acoustics, involving a "sound wave front" picked up by a microphone "screen" to take the place of the usual proscenium.

Another method under their study includes an acoustical control chamber or "well" to which sound waves would be reflected. Sonic effects can be electrically superimposed on these fundamental waves.

(*Continued on page 110*)

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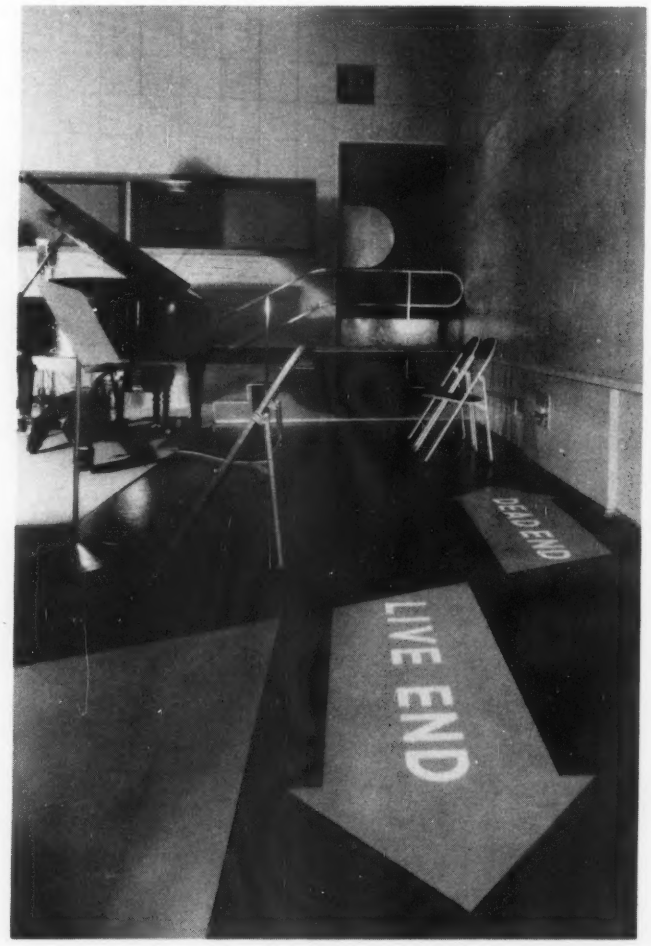
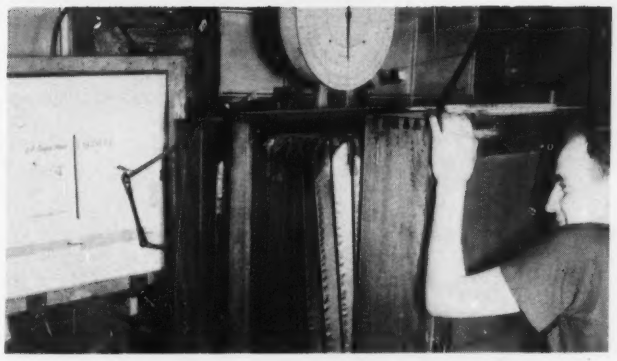


THE T.E.N. GOES TO PRESS

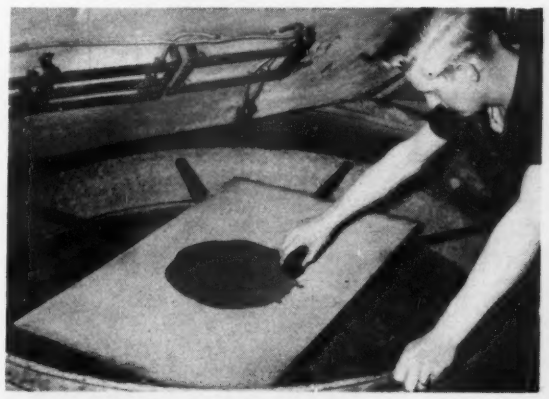


1 Before each issue's material is sent to the printer, the "Art" Staff indicates the size, shape, and placement of each picture and the arrangement of type matter on a blank "dummy" of the magazine. Written material is then set up in ordinary type and put into a conventional flat press. From this press comes, first, proof sheets which are corrected by the staff, and finally the master copy. Spaces for photographs are blank at this stage.

2 Master copy is photographed by copying camera. Then pictures to appear in TECH ENGINEERING NEWS are photographed through a half-tone screen. If pictures are not the right size, corrections can be made.

3 On this table negatives of printed copy and pictures are composed into a complete page.

4 Pouring a light, sensitive layer over an acid-cleaned sheet of zinc. The zinc plate is



then whirled in the centrifuge, forming a uniform film of sensitive material.

5 The sensitized zinc sheet is placed in a large printing frame in close contact with negatives shown in (3) and exposed by means of strong arc lights. The plate is then coated with ink and placed in running water. All parts not exposed to the light will now dissolve. The zinc plate thus made is clamped upon the rotary press shown at the right.

Inset shows the addressing of envelopes by means of *addressograph.*

THE FEWER, THE BETTER

The demand of the times for more production per dollar, without sacrifice in quality, brings into sharper and sharper focus the necessity for the use of the most modern materials. It is natural that the more different steels specified in machine construction, the greater the fabrication and stock room complications.

To reduce these complications, many manufacturers are taking advantage of the versatility of Molybdenum Steels. One, a builder of a varied line of heavy duty machines, replaced four different alloy steels with Chromium-Molybdenum Steel (SAE 4140) for everything from heavy crank shafts to small screw machine parts.

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MOLY

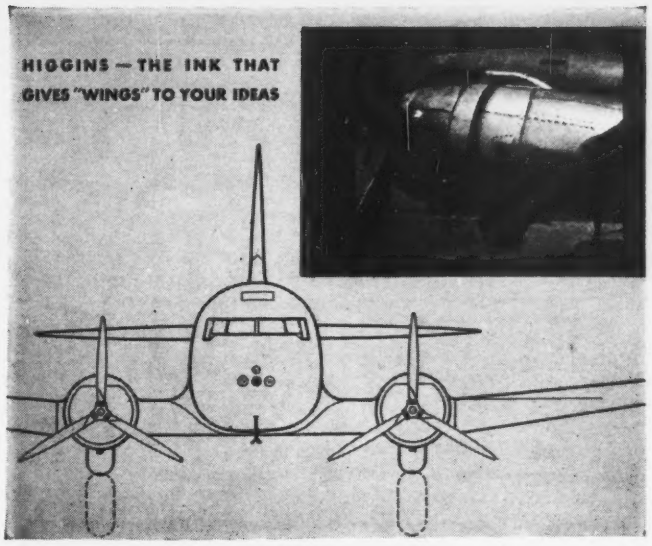
AERONAUTICAL

(*Continued from page 99*)

sive stress analyses made by senior engineers on some major part of an airplane, assisting in checking weights of airplane parts, assisting in running engines on test stands, in taking wind tunnel or other experimental data, and in computing the results. Often new graduates are given a six or twelve month rotational apprenticeship training, during which they work in the various departments of a factory, before they are assigned to one of these positions. Starting pay is normally $30 or $35 per week, with security of employment rather unsatisfactory during the first three years or so.

Typical high positions reached in aeronautical engineering are: chief stress analyst, chief draftsman, project engineer (who is responsible for a single order of airplanes on production in a factory), chief engineer, aeronautical inspector (who examines pilots, mechanics, aircraft, engines, schools, etc. for Civil Aeronautics Authority certification), airline or test pilot, air transport engineer (who is responsible for the engineering required on airplanes in service and for the writing of specifications for new equipment), and professors of aeronautical engineering. Salaries for such positions range from $4,000 to $15,000 a year.

For the last ten years the salary promotion rate has averaged, for M. I. T. men, approximately $200 per year. Chances for satisfactory placement have averaged about six to ten at graduation, and about nine to ten by the following September. Because of the war, all these figures will now probably improve considerably.



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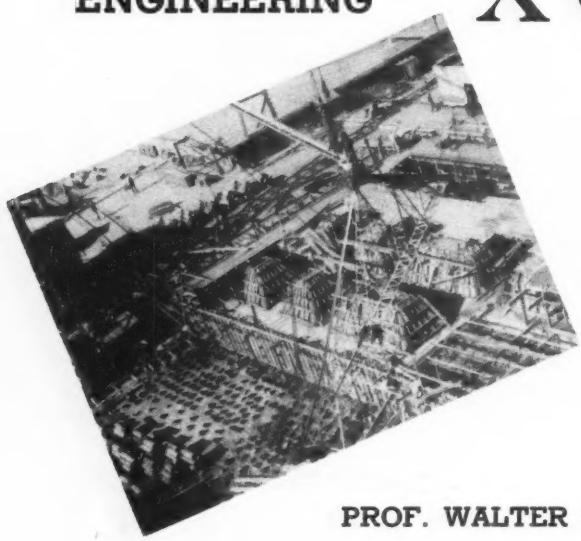
BUILDING CONSTRUCTION and ENGINEERING XVII



PROF. WALTER C. VOSS

Young men who wish to make some phase of the building industry their chosen life's work will find in the course in Building Engineering and Construction a broad base upon which to build their future. The course provides the fundamental scientific and technical training of the engineer and amplifies this work by a thorough study of the sequence and details of construction, of materials, and many basic business aspects.

Opportunities for employment are spread over a broad field because the curriculum affords the student training in several important aspects of the industry. The young man who desires to make structural design his chosen field will have an adequate appreciation of the problems of the architect as well as being grounded in the fundamentals of structural engineering, materials and constructions. In an architect's employ he may make himself useful in the development of details of construction, the selection of proper materials, the preparation of specifications and preliminary estimates and in the supervision of actual construction. If he chooses to work with a contractor he may act initially in the capacity of job engineer and eventually as a superintendent of construction. He may become indispensable to a manufacturer of materials because of his scientific approach to the problems which confront his employer. He may find an outlet for his ability with a bank, an insurance company or a realty company, where he will be concerned with the evaluation of financial risks, in the assessment of values and in the repairs, maintenance and management of properties.

The provision which is made for summer coöperative employment between the third and fourth year will serve to amplify his appreciation of the problems of the industry as well as to afford him an excellent opportunity for placement after graduation. The student who has chosen this course wisely may look forward to a future as principal or manager in one of these fields. Which he will be best fitted for will depend upon his natural qualifications and his own initiative.

XVIII

Technology Review

MATHEMATICS

PROF. HENRY B. PHILLIPS

Students who major in mathematics have three opportunities for placement corresponding to the three options into which Course XVIII is divided.

Option 1, pure mathematics, is mainly preparation for a career of research and teaching. An occasional graduate of this option may obtain placement in a secondary school or junior college. Most of them, however, find it necessary to continue with graduate work to the Ph.D. before obtaining employment. If the candidate has an acceptable personality, is a satisfactory teacher,

(*Continued on page 108*)

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MATHEMATICS

(*Continued from page 107*)

and has capacity for mathematical research, a college teaching position may then be expected.

Option 2, applied mathematics, is provided for those who are more interested in applications than in the underlying mathematical theory. A graduate in this option may find employment in a research laboratory or manufacturing concern where design work makes use of mechanics, theory of elasticity, and theory of vibration. Finally, for men who can do really worthwhile applied mathematical research, the demand is always greater than the supply. In fact it has been necessary to import most of the men doing such research in this country.

Option 3, industrial statistics, is preparation for work in which statistical interpretation of data is important, and for the actuarial profession. Students who pass the actuarial examinations usually find employment with the insurance companies. For much advancement, however, it is necessary that the candidate have personal qualities which qualify him for executive positions or to act as representative of the company in outside business contacts. Industrial work of a statistical nature consists mainly of sampling studies made for quality control. In addition to technical knowledge of statistics, success in such work is dependent largely on common-sense and ability to get the coöperation of other employees. For men who have these qualities, there is considerable demand.

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XIX

METALLURGY PROF. R. S. WILLIAMS

The recovery of metals from their ores and the making of alloys antedates written records and was probably one of the first occupations of prehistoric man. Only during the last fifty years, however, has metallurgy changed from an art to a highly specialized science.

The science of metallurgy is today divided into two major parts, which while closely inter-related are still distinctly different. The older division deals with the recovery of metals from their ores and is called *production* or *process* metallurgy. It depends largely on chemical reactions. The second branch has to do with the

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Foreword by Karl T. Compton, President of Massachusetts Institute of Technology.

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properties, uses, and possible defects of the metals and alloys and has come to be known as *physical* or *adaptive* metallurgy. Its study is based largely on physical measurements. A minor and rather artificial subdivision in both groups is a classification into ferrous alloys in which iron is the main constituent, and also the nonferrous group in which iron is not present at all or only in minor percentages.

In the production field the duties of the metallurgist are essentially (1) the preparation of the ore, (2) the design and operation of equipment for production, and (3) research and development leading to the improvement of older processes and to the introduction of new methods of manufacture. The opportunities in the field of physical metallurgy may be grouped approximately as follows: (1) the fabrication of metal parts such as tubes, plate, sheet, wire, and the like; (2) the selection of metals and alloys for given purposes and inspection for defects or unsuitable characteristics; (3) research in the field of alloys. This may consist of fundamental studies with no apparent immediate application and requires training of the highest type as well as special aptitude, or it may be for the specific purpose of improving a standard alloy or for developing a new one to meet definite engineering needs. Finally it should be said that the selling of metallurgical products has become a highly specialized profession and demands a high type of technical training.

The subjects offered in Course XIX are planned to train men in all branches of metallurgy, although electives in the fourth year permit some specializing in that field in which a man finds himself most interested.

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(*Continued from page 102*)

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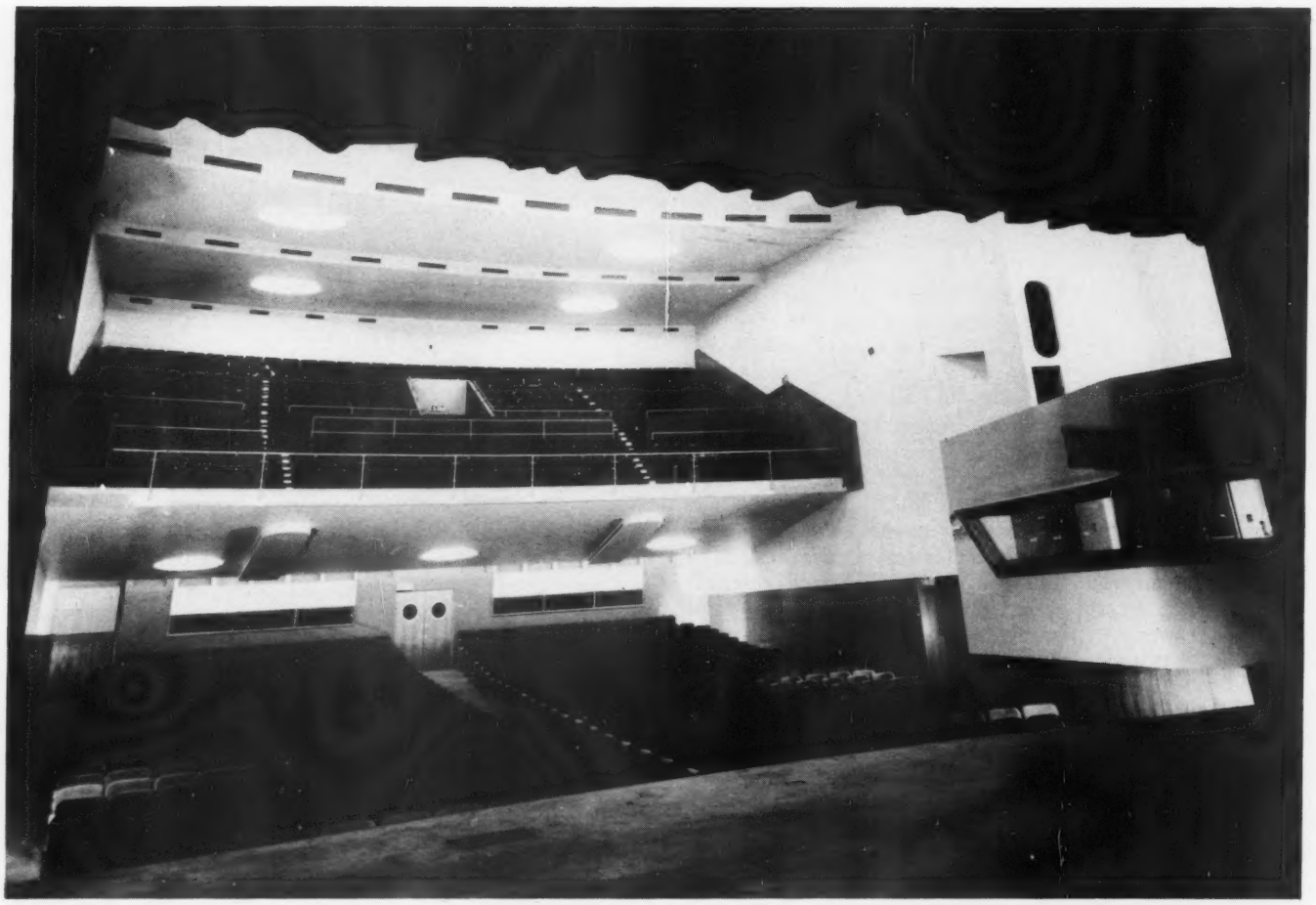

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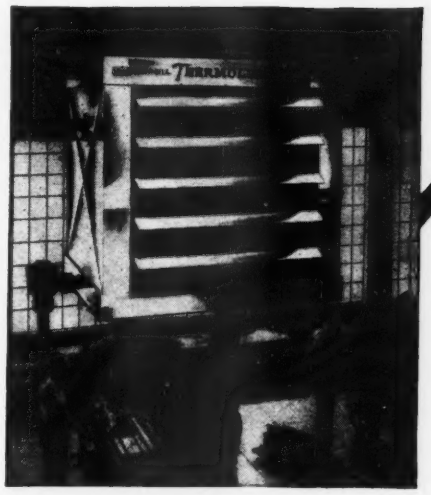

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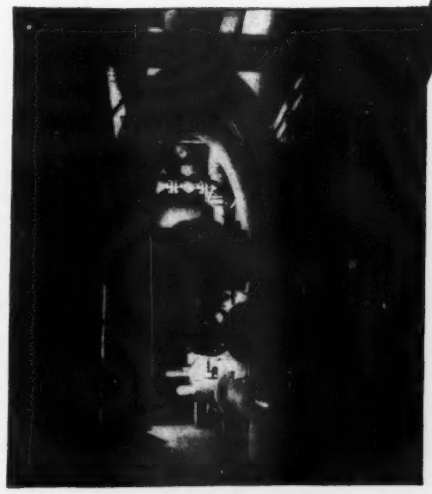

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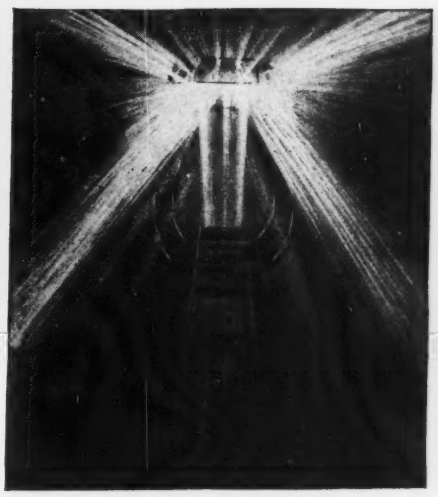

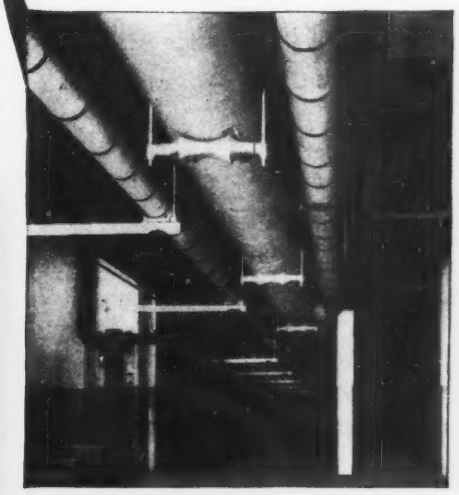

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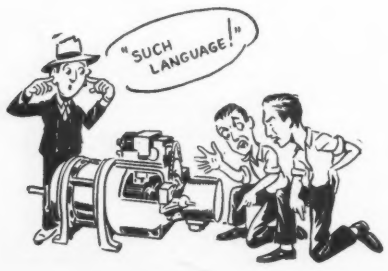
G-E Campus News

ENTERTAINING ROYALTY— BY PROXY

WHEN Great Britain's King and Queen visited the New York World's Fair on their international social call, 20 farmers were able to watch the royal pair as closely as if they were entertaining Their Majesties out on the farm. And the rural folk were 130 miles away from the Fair grounds.

This long-distance watching was made possible by G-E television engineers. Directed by C. A. Priest, Maine '25 and ex-Test man, radio engineer for General Electric, they were simply proving that television programs could sometimes be received at a far greater distance than the previously supposed limit of 40 to 50 miles.

For, instantly and clearly, while the King and Queen inspected the Fair, television reproduced complete details of their visit to the group—130 miles away, atop the Helderberg Hills near Schenectady. Not far from the scene of this experiment is General Electric's powerful new television station, W2XB, soon to go on the air.



TECHNICAL DOUBLE TALK

WALKING through one of General Electric's factory buildings, a visitor paused in front of two young men kneeling in front of an electric motor. He was mystified to hear, "Say, Bill, put a tac on that BTA, and after you've hooked up the pots and c-t's and plugged power, see if she still swings and hunts!"

All of which made as much sense to the visitor as "gate," "jive," "alligator," and similar swing-music terms mean to a symphony conductor. Translated, the young man was merely asking his co-worker to connect certain instruments to the motor, turn on the power, and notice whether the motor ran smoothly.

Few of the graduate engineers selected by General Electric for its Test Course are familiar with this Test man's jargon when they arrive. But after a few days in the shops the new man, too, is rattling away in the technical double talk as expertly as his elders.

TRAVELING HOTEL

NEXT Spring, when a hotel-on-wheels rolls into Bombay, India, some of the citizenry may have grave doubts about their sanity. Or they may blame the blazing tropical sun. They'll be wrong. Lawrence Thaw's trans-Asiatic motorcade will be completing a 14,000-mile safari from Paris.

Quite obviously, such things as 14,000-mile trips require quite a bit more than *savoir-faire* and an adventuresome spirit. Preparation, and plenty of it, was required by Mr. Thaw. This brought into the picture—both directly and indirectly—G-E engineers.

The four mobile units of the motorcade boast of the latest G-E two-way radio, for maintaining contact between the various vehicles throughout the journey. During tests two of the units maintained contact when as far as 200 miles apart. Air conditioned throughout, the deluxe trailer contains all the appliances and equipment normally found in a modern home—from tiled bath and indirect lighting to an array of electric appliances.

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